Abstract

NASA's Sixteenth Annual Continual Improvement and Reinvention Conference

MSFC's entry into this CI conference:

Structural Loads Test Measurement Acquisition System (SLTMAS)

This presentation package, a PowerPoint presentation, will be presented at the aforementioned NASA conference as part of an Agency level competition highlighting continual improvements within the NASA. The presentation provides a brief overview of the process used to improve the Structural and Dynamics Testing Group's data acquisition capabilities. Results measuring the success of the improvement cycle for the PC based SLTMAS will be presented.


Structural
Loads
Test
Measurement
Acquisition
System
ALAN F. PATTERSON
Structural & Dynamics Testing Group
Structures, Mechanics, & Thermal Department
Engineering Directorate
Marshall Space Flight Center

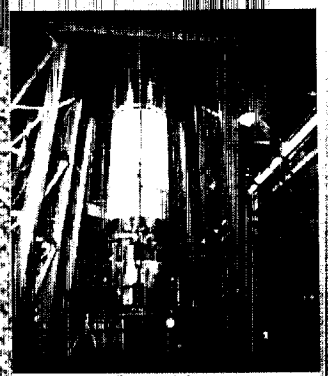
Agenda

- SLTMAS - What is it?
- Continuous Improvement activities
- Continuous Improvement results

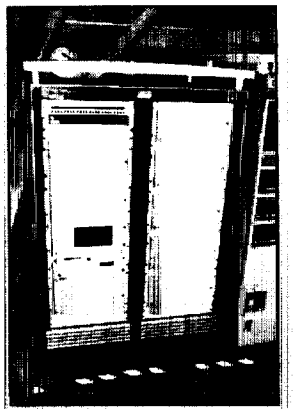
History

- The Structural and Dynamics Testing Group at MSFC has been involved in continual improvement of testing tools for over thirty years.
- The SLTMAS data acquisition system has been used for structural strength testing of most major NASA space flight hardware from Saturn V to the International Space Station.

Mainframe SLTMAS

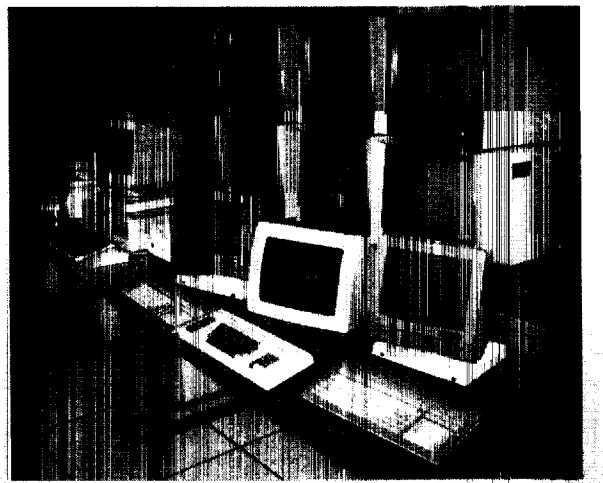


70" Lox Tank-Saturn I
Aft & Forward Skirt Loads Test



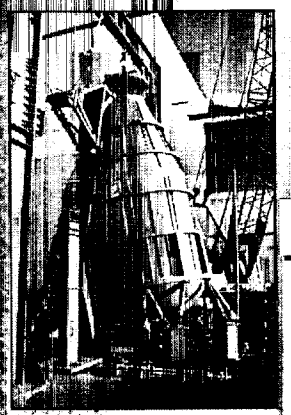
Signal Conditioning

Operator's Console



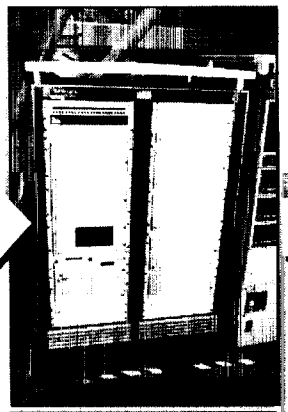
Data Collector/Control Station

PC-SLTMAS



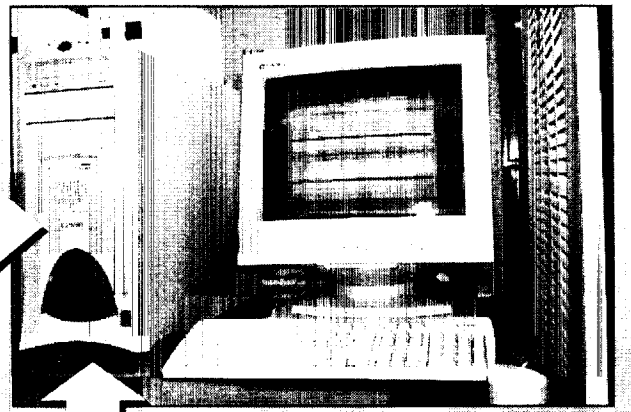
X-33 LOX Tank

Sensors



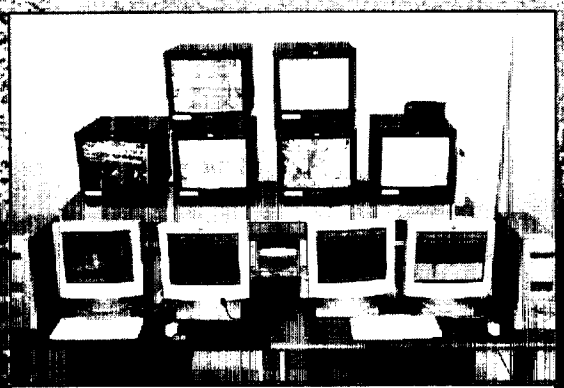
Signal Conditioning

Digital Scans



Data Collector

Ethernet

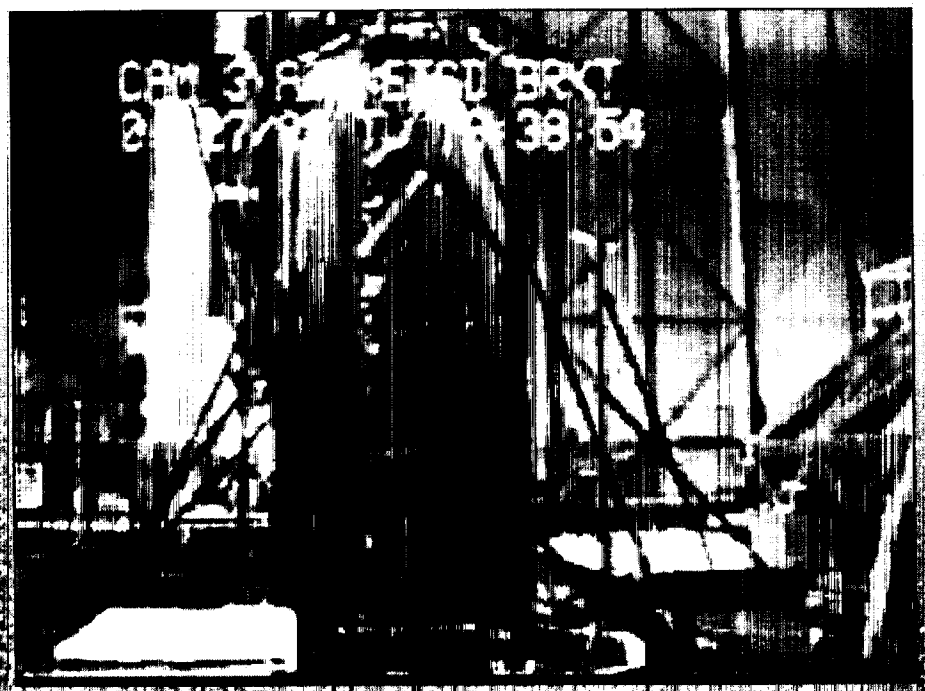


Stress Analyst Stations

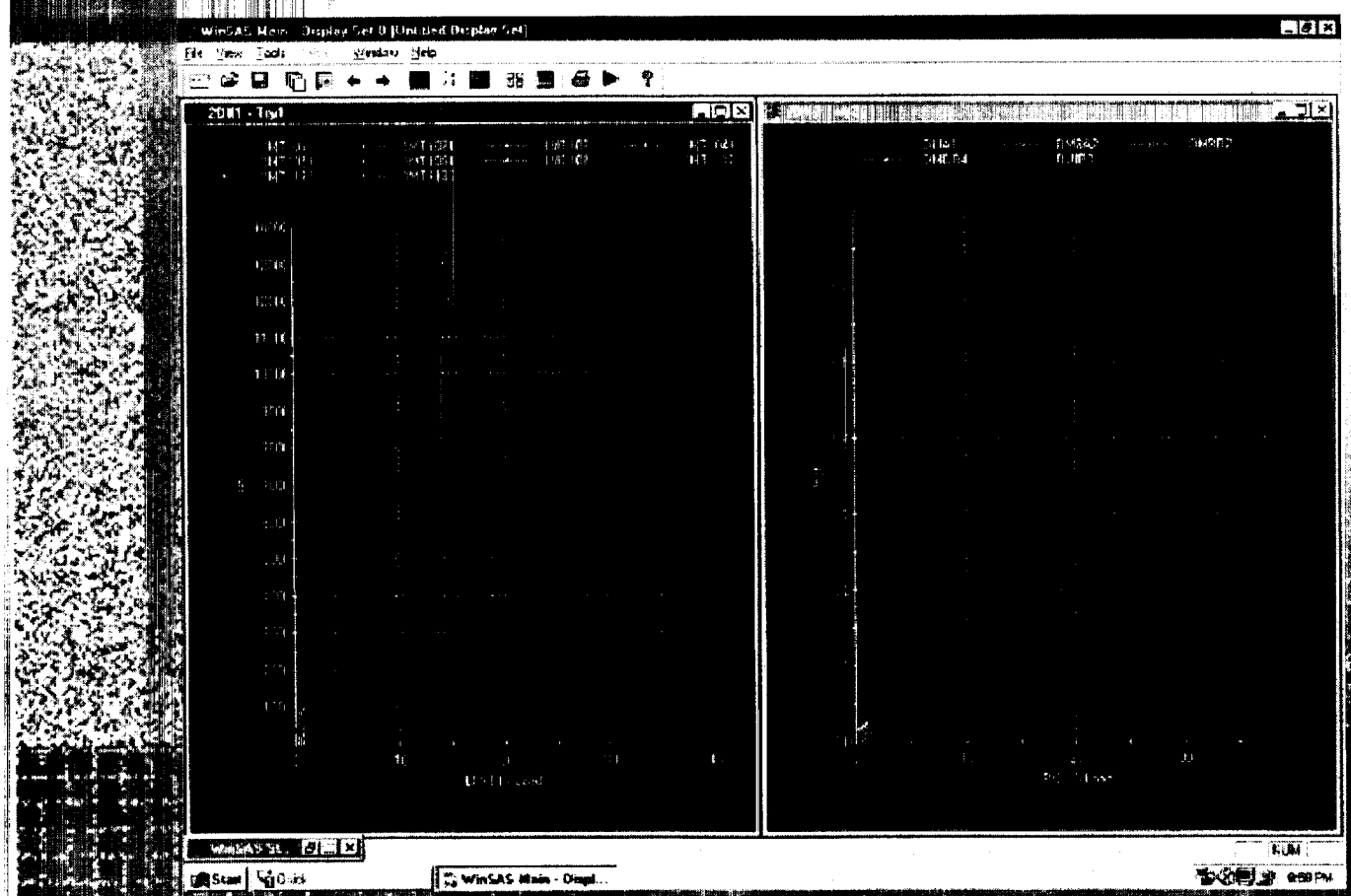
Ethernet

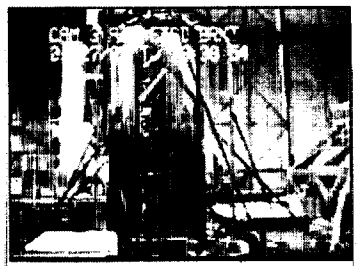
Control Station

PC-SLTMAS at Work



PC-SLTMAS at Work





PC-SLTMAS Team

Core Team Members

NASA MSFC

Computer Sciences Corporation

Spike Software, Inc.

Pearson Consulting

Dynamics Concepts, Inc.

Industry Team Partners

Engineering Design Team, Inc.

Microsoft

Compaq

SDRC

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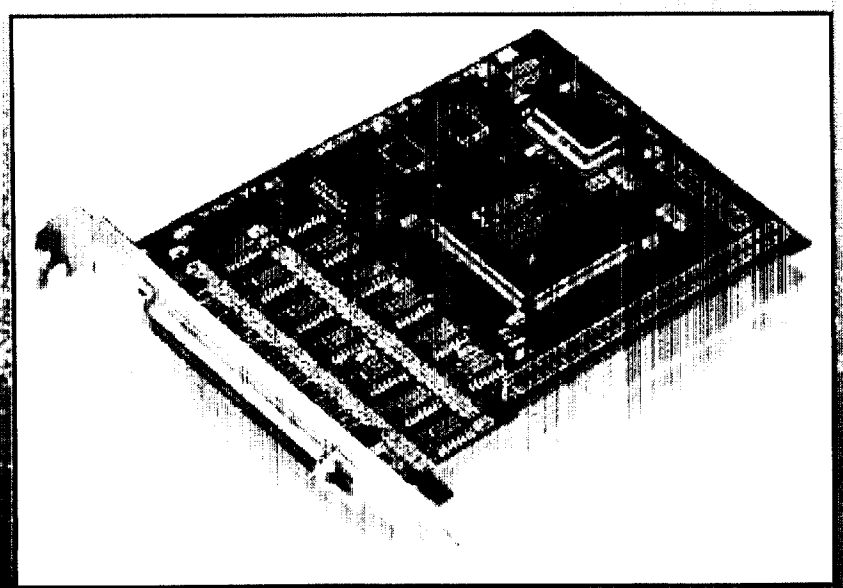
Add EDT logo

Engineering Design Team, Inc.

- **PC card emulates the mainframe data bus**
- **Enables reuse of existing high speed data acquisition hardware**



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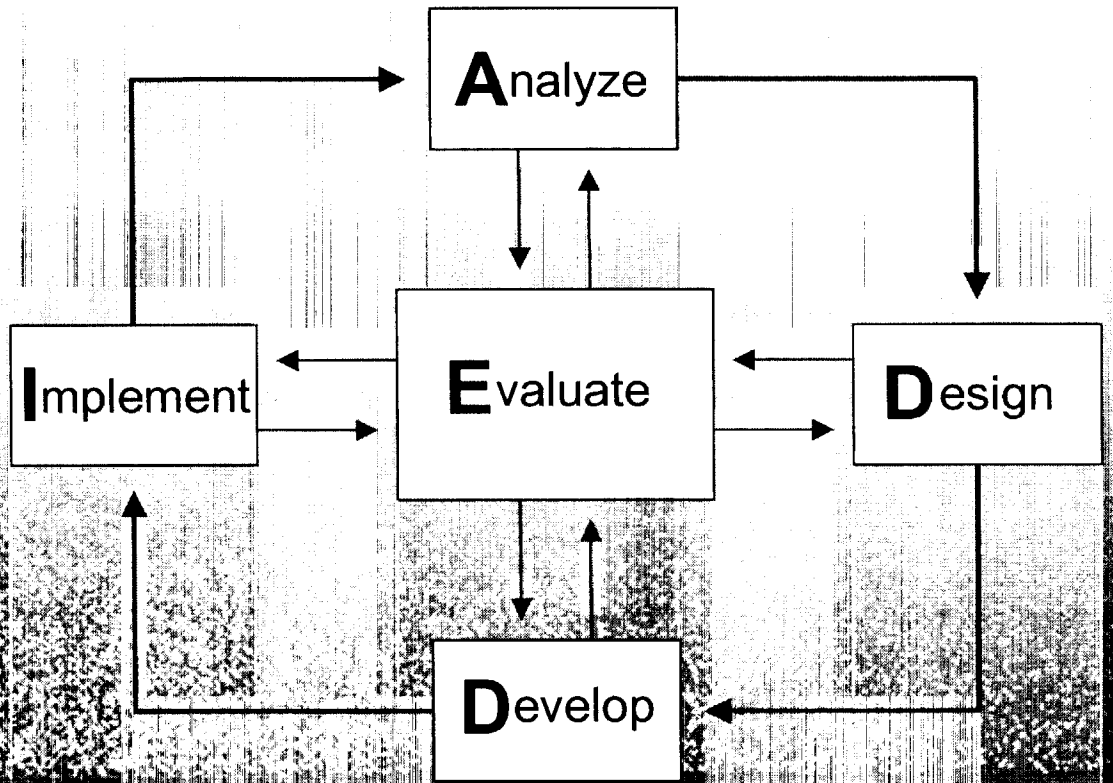
Add CSC logo

MSFC/ Computer Sciences Corporation

- **Provides system design, development and implementation**

MSFC/CSC photo

Continuous Improvement Model



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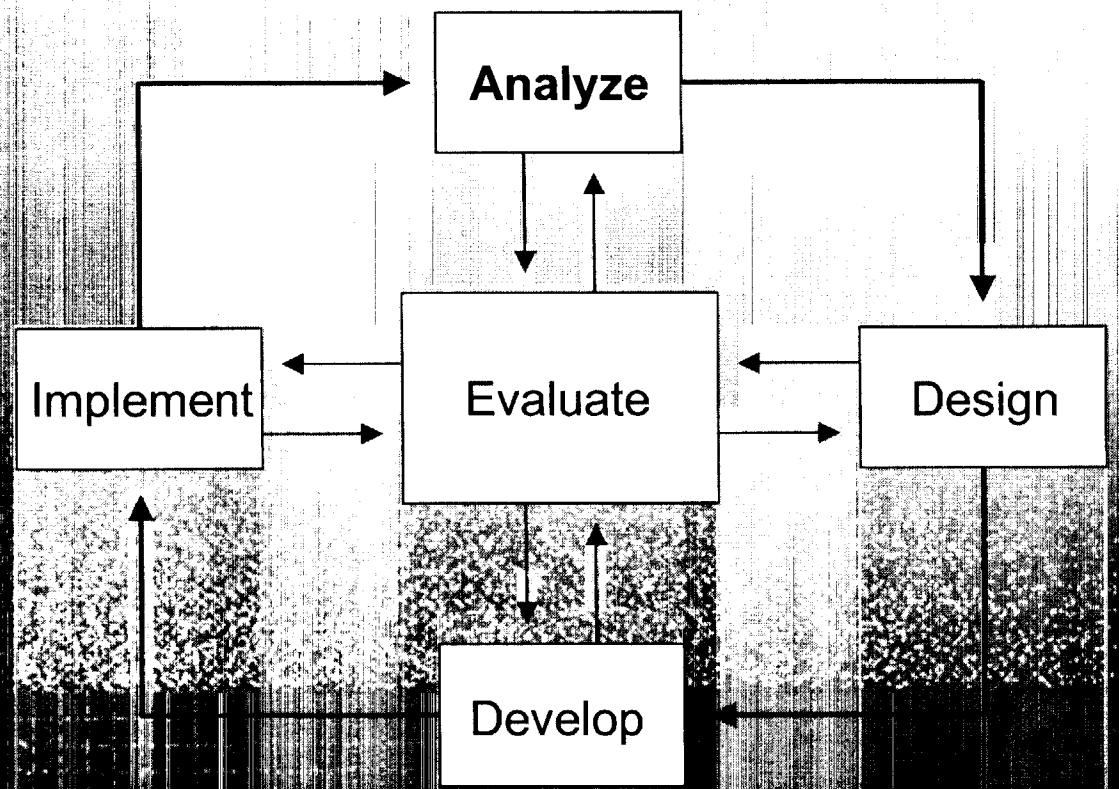
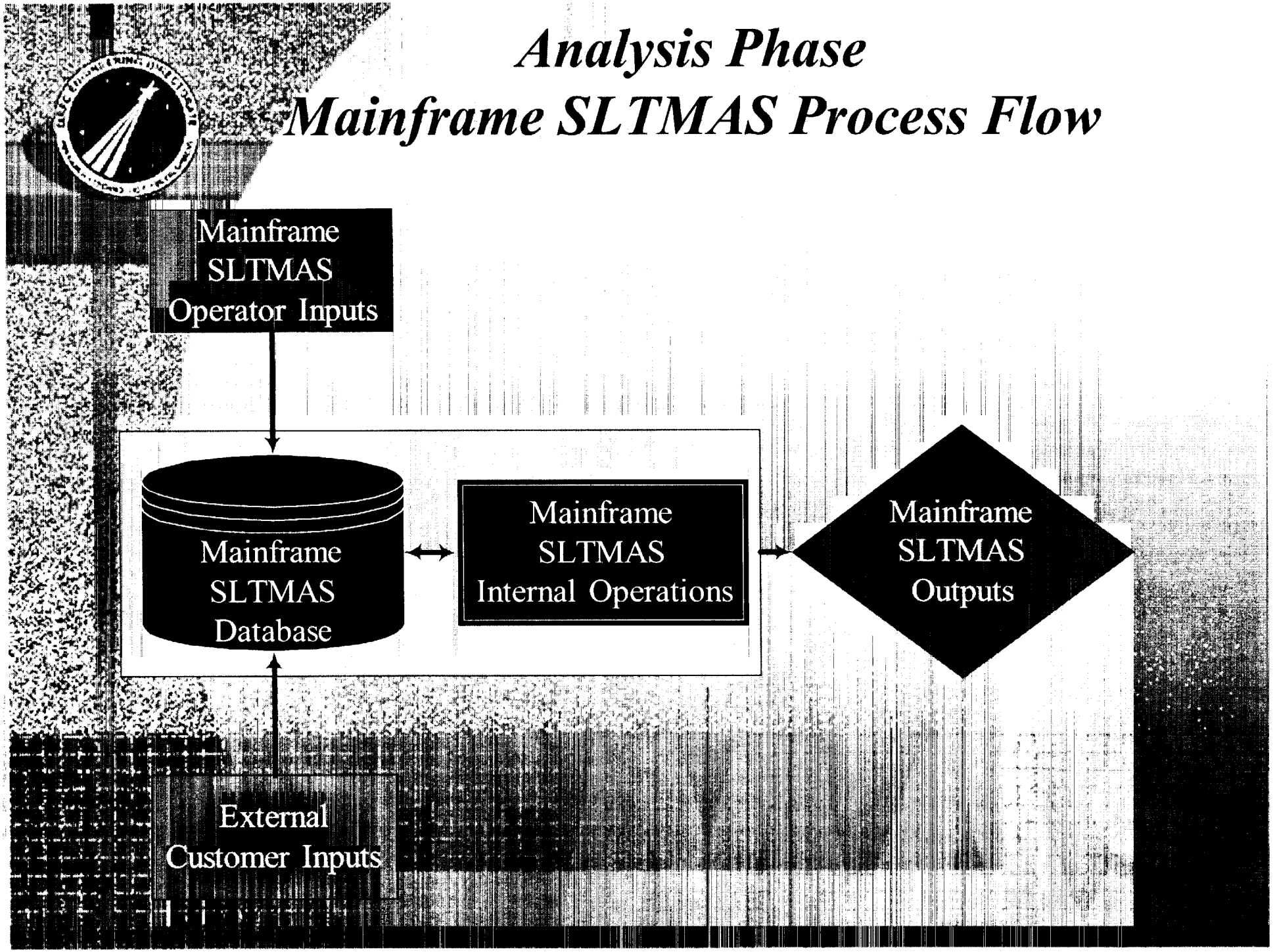
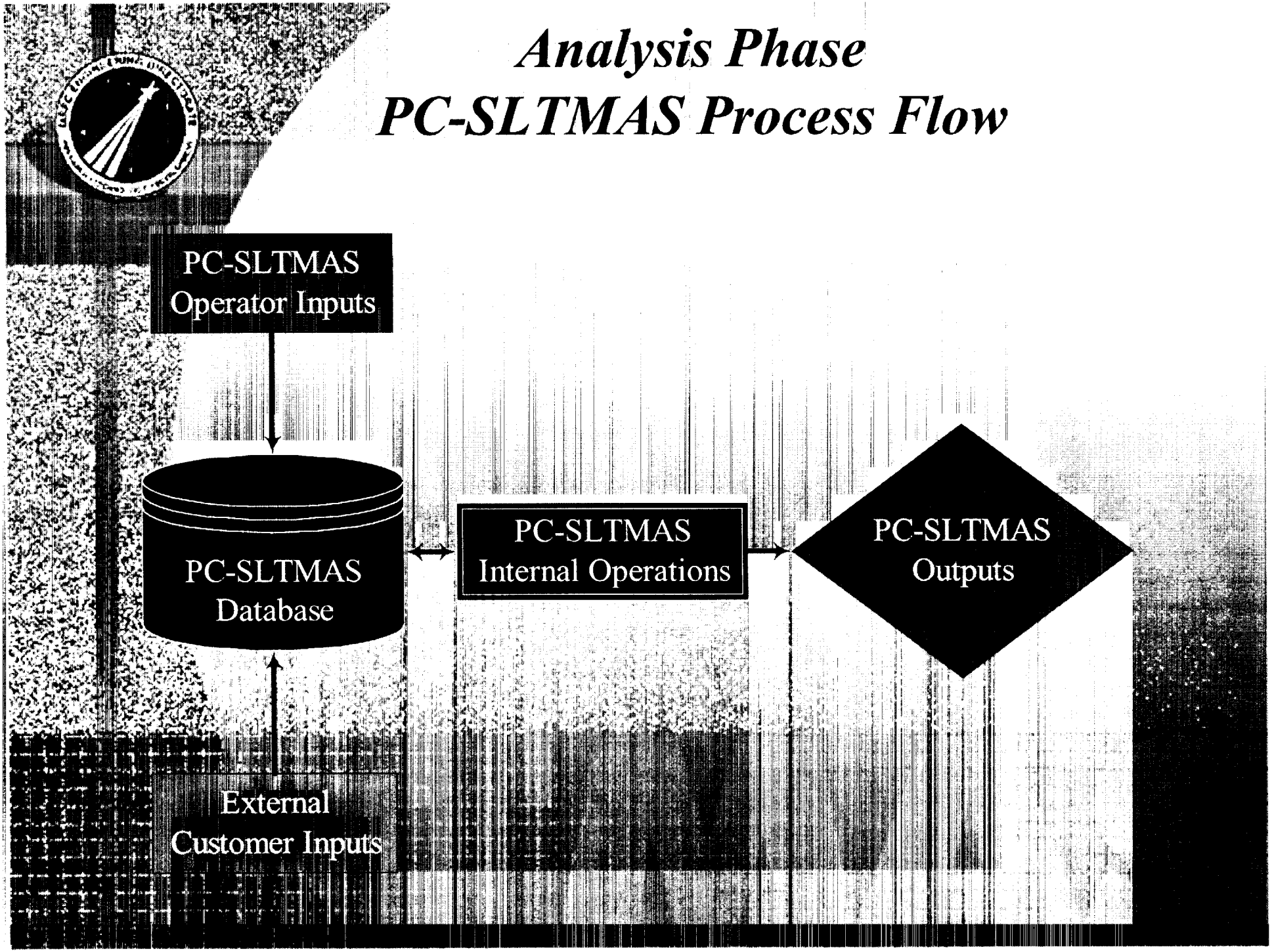
Phase I: Analyze



Analysis Phase
Mainframe SLTMAS Process Flow



Analysis Phase
PC-SLTMAS Process Flow



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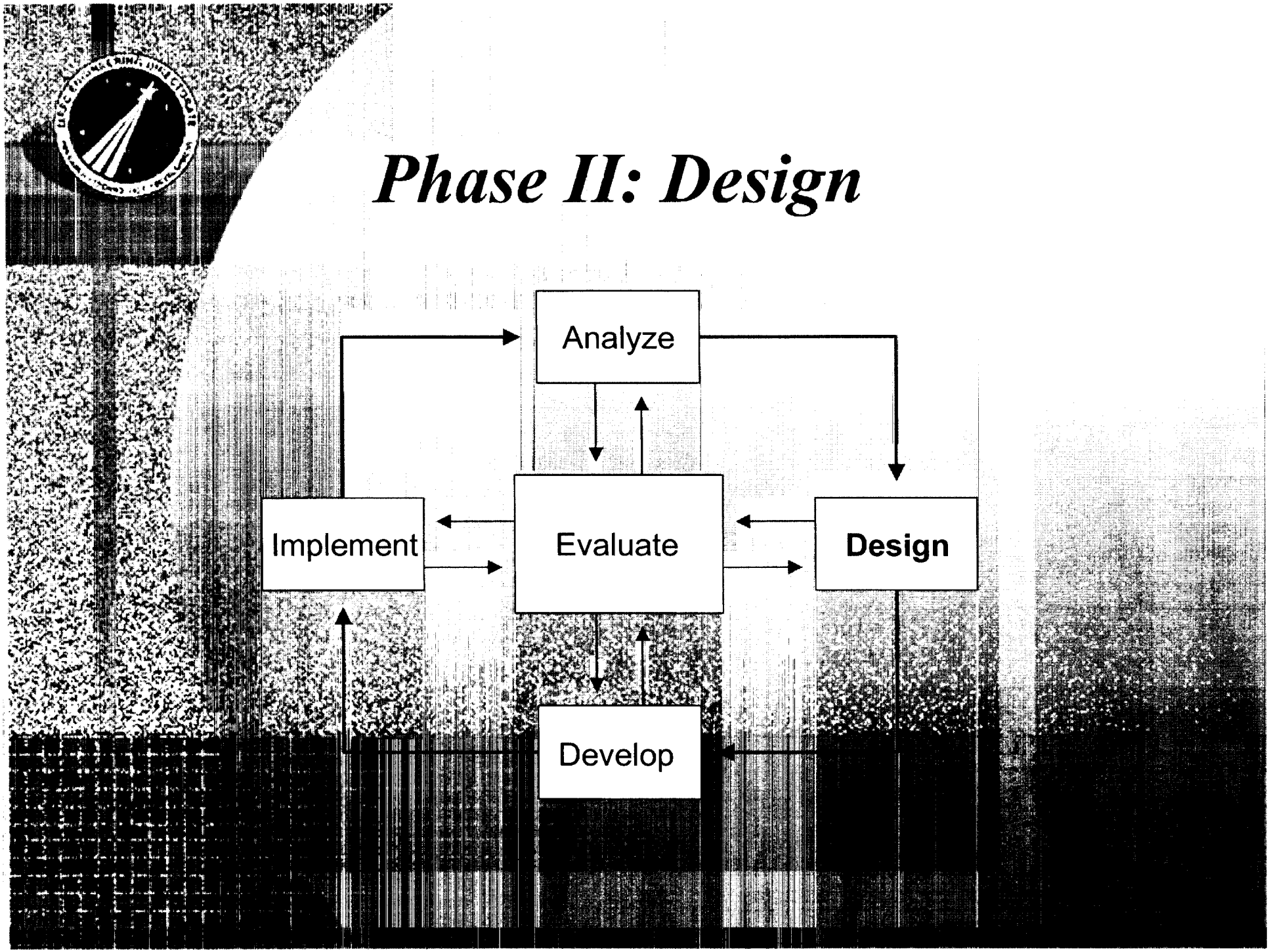
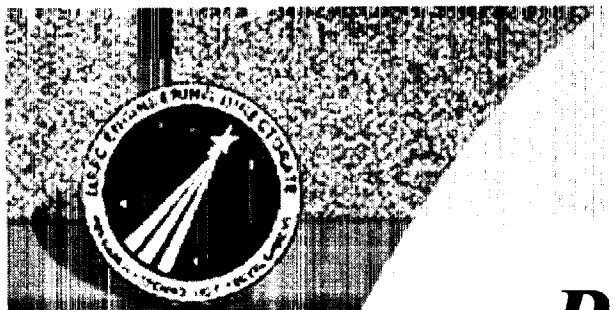
Analysis Phase

- **Problem Statement**
  - **Mainframe SLTMAS cannot economically meet increased demand for large-scale structural strength test services**
    - **High upgrade and maintenance costs**
    - **Extensive schedule time required between tests for system pre- and post-test operations**
    - **Historically demonstrated long software development and integration time**

Phase II: Design

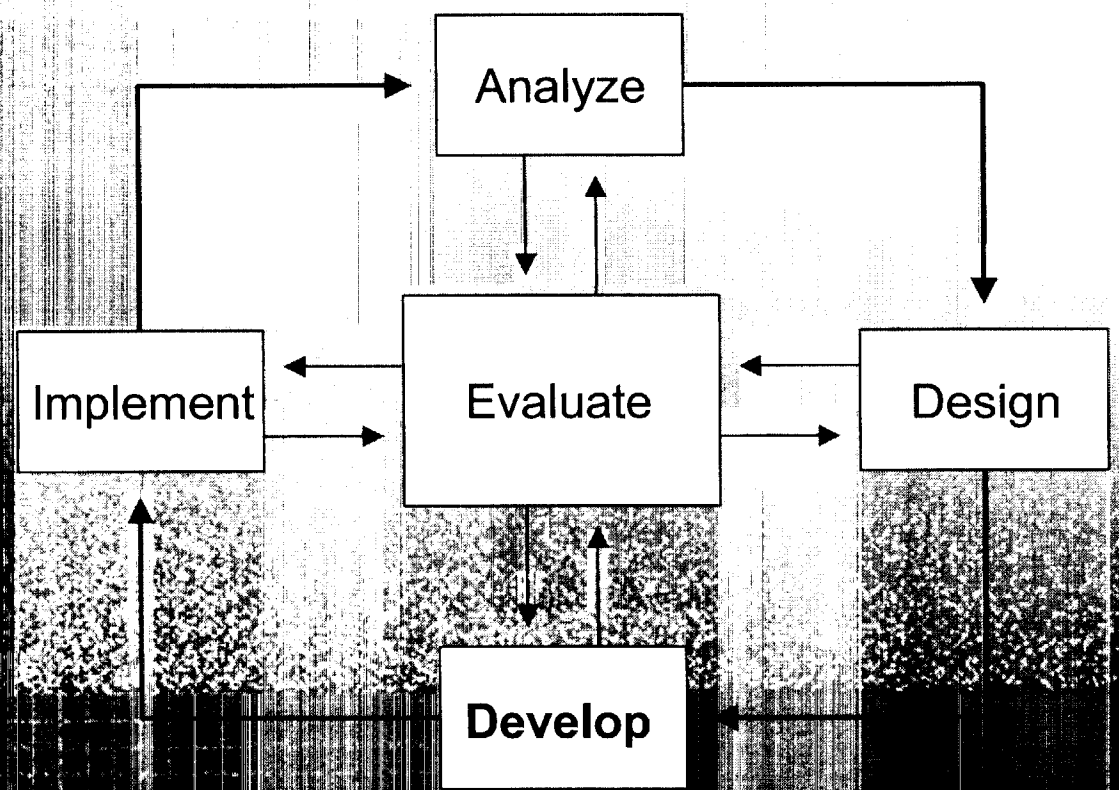




Design Phase Performance Objectives

- Use off-the-shelf, open source solutions vs. proprietary systems
- Increase SLTMAS capacity to support four large tests simultaneously
- Decrease data acquisition system operations time by 50%
- Maintain data recording rate capability
- Implement solution within two years

Phase III: Develop

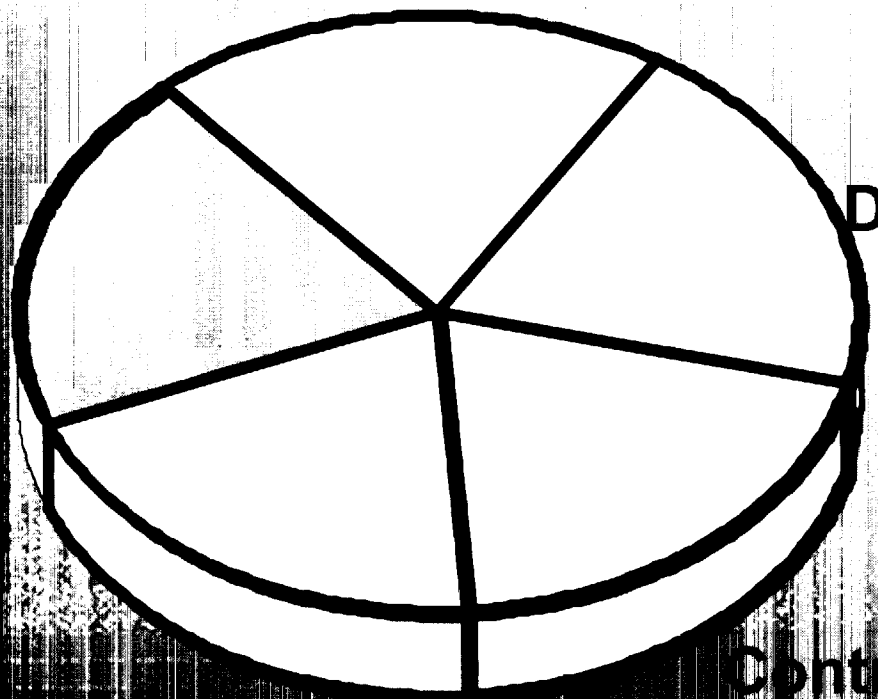


See rough draft

Development Phase Mainframe SLTMAS

PC-SLTMAS

Signal Conditioning



Data Collector

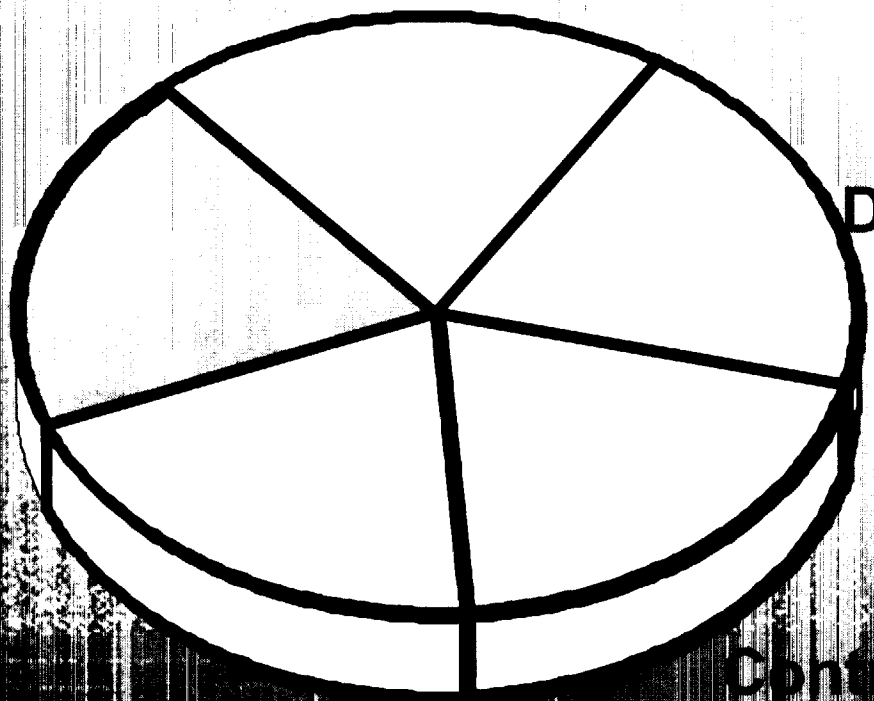
Control Station

See rough draft

Development Phase Action Plan PC-SLTMAS

PC-SLTMAS

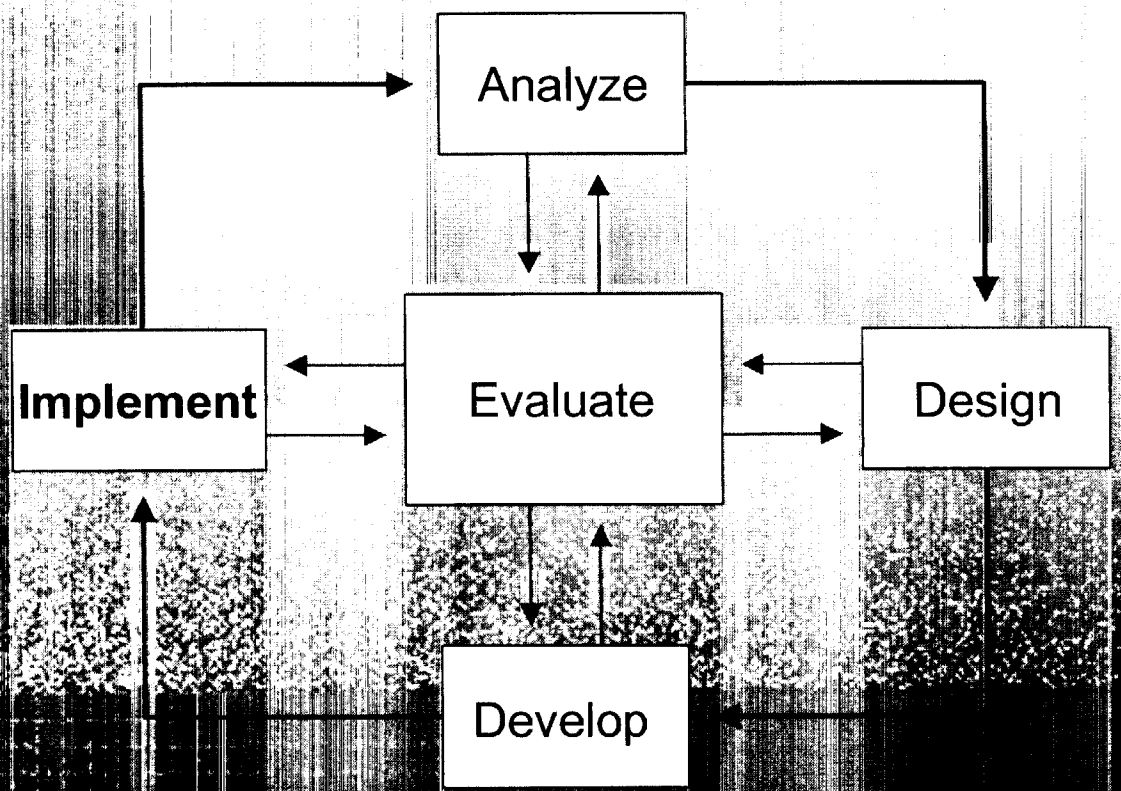
Signal Conditioning



Data Collector

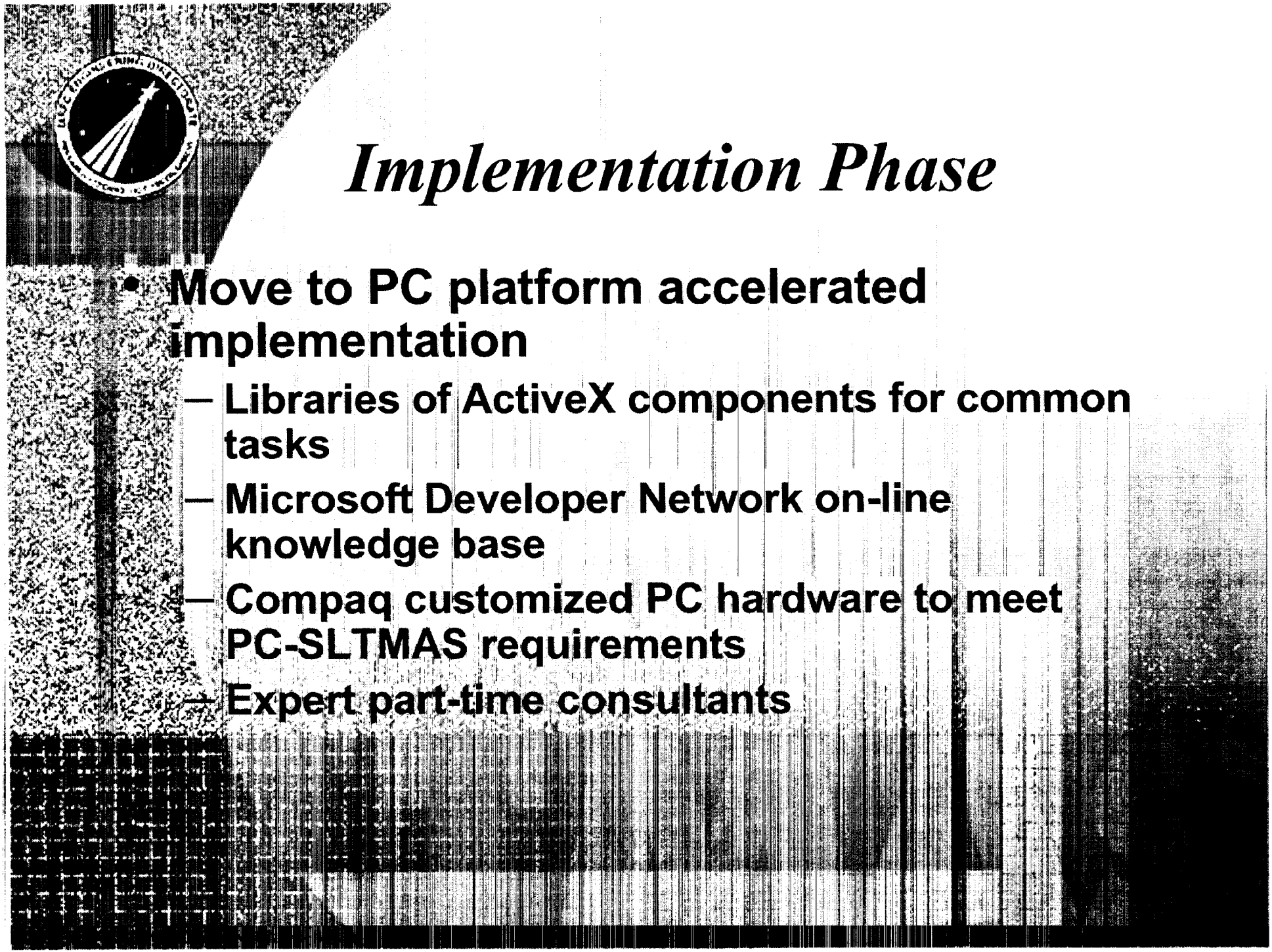
Control Station

Phase IV: Implement



Implementation Phase

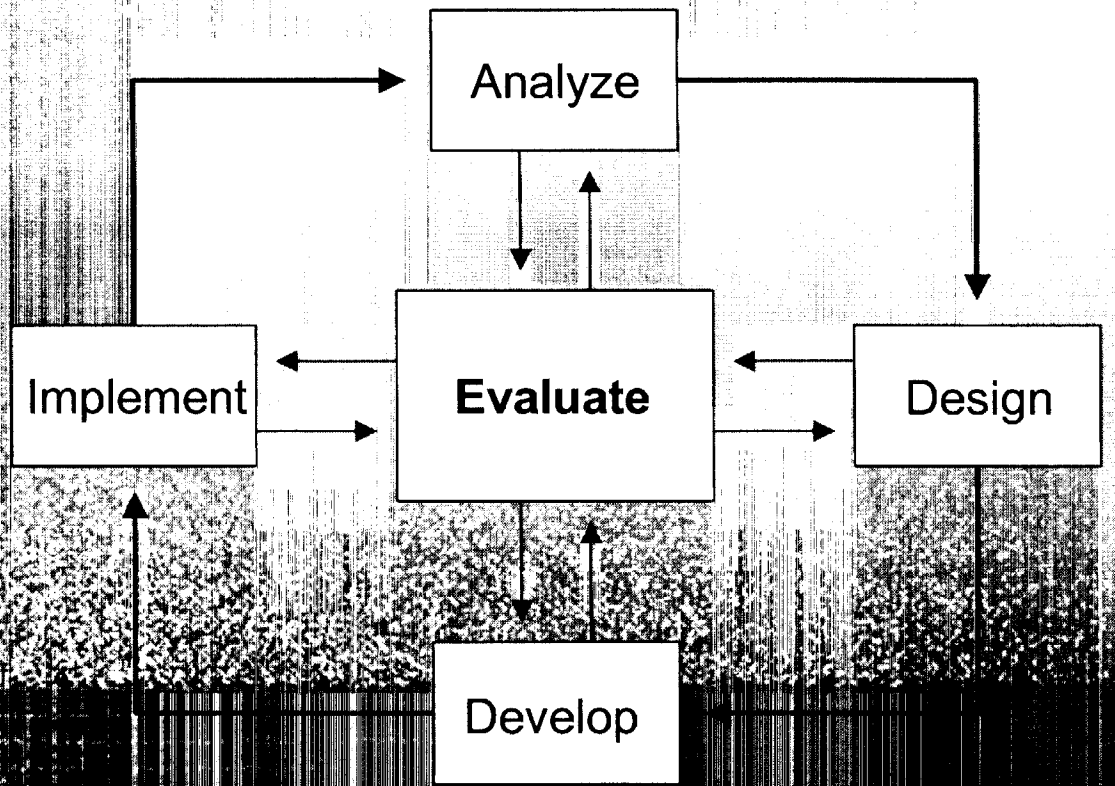
- **Team Efficiency**
  - **Improved communications through team member co-location**
  - **Ensured "buy-in" to the implementation strategy through involvement of all team members in each phase of the process**



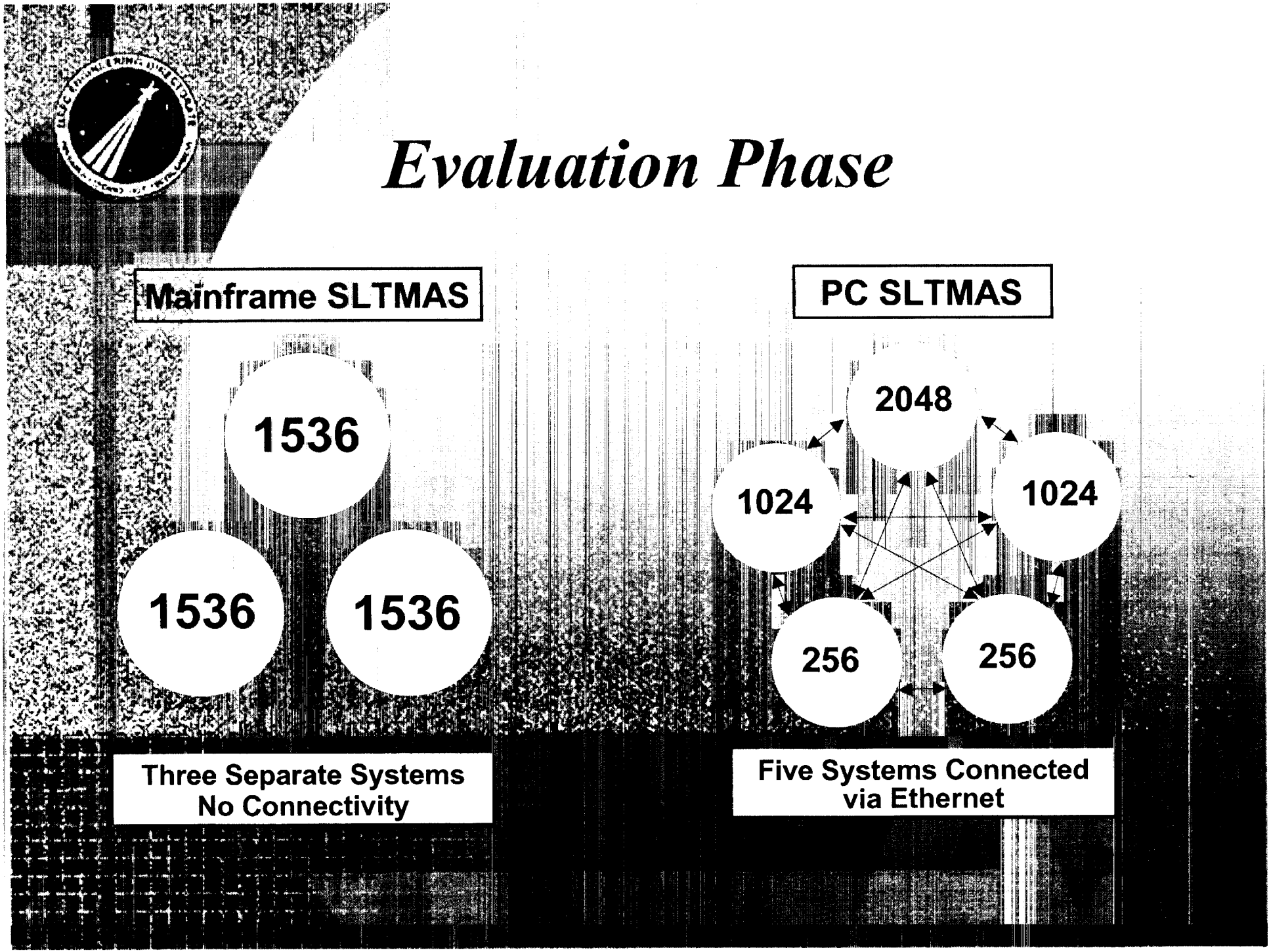
Implementation Phase

- **Move to PC platform accelerated implementation**
  - **Libraries of ActiveX components for common tasks**
  - **Microsoft Developer Network on-line knowledge base**
  - **Compaq customized PC hardware to meet PC-SLTMAS requirements**
  - **Expert part-time consultants**

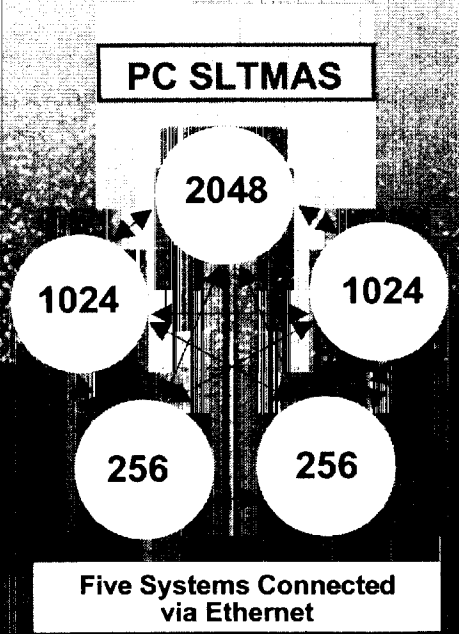
Phase V: Evaluate



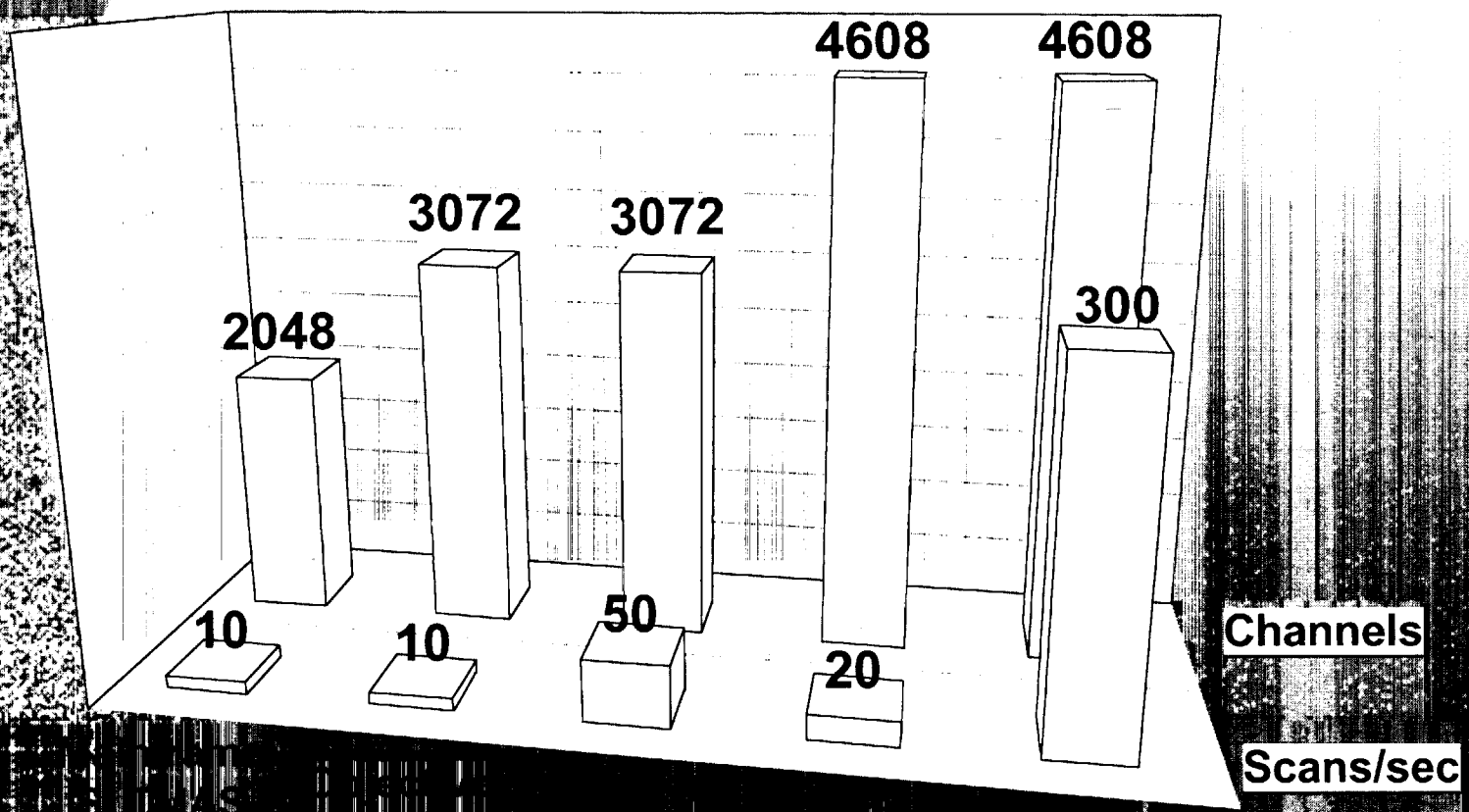
Evaluation Phase



Evaluation Phase



Evaluation Phase
Metric: Channel Count & Scan Rate



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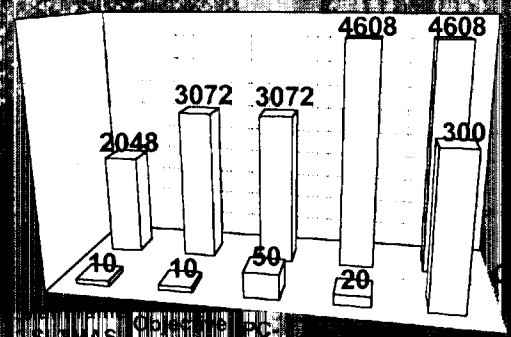
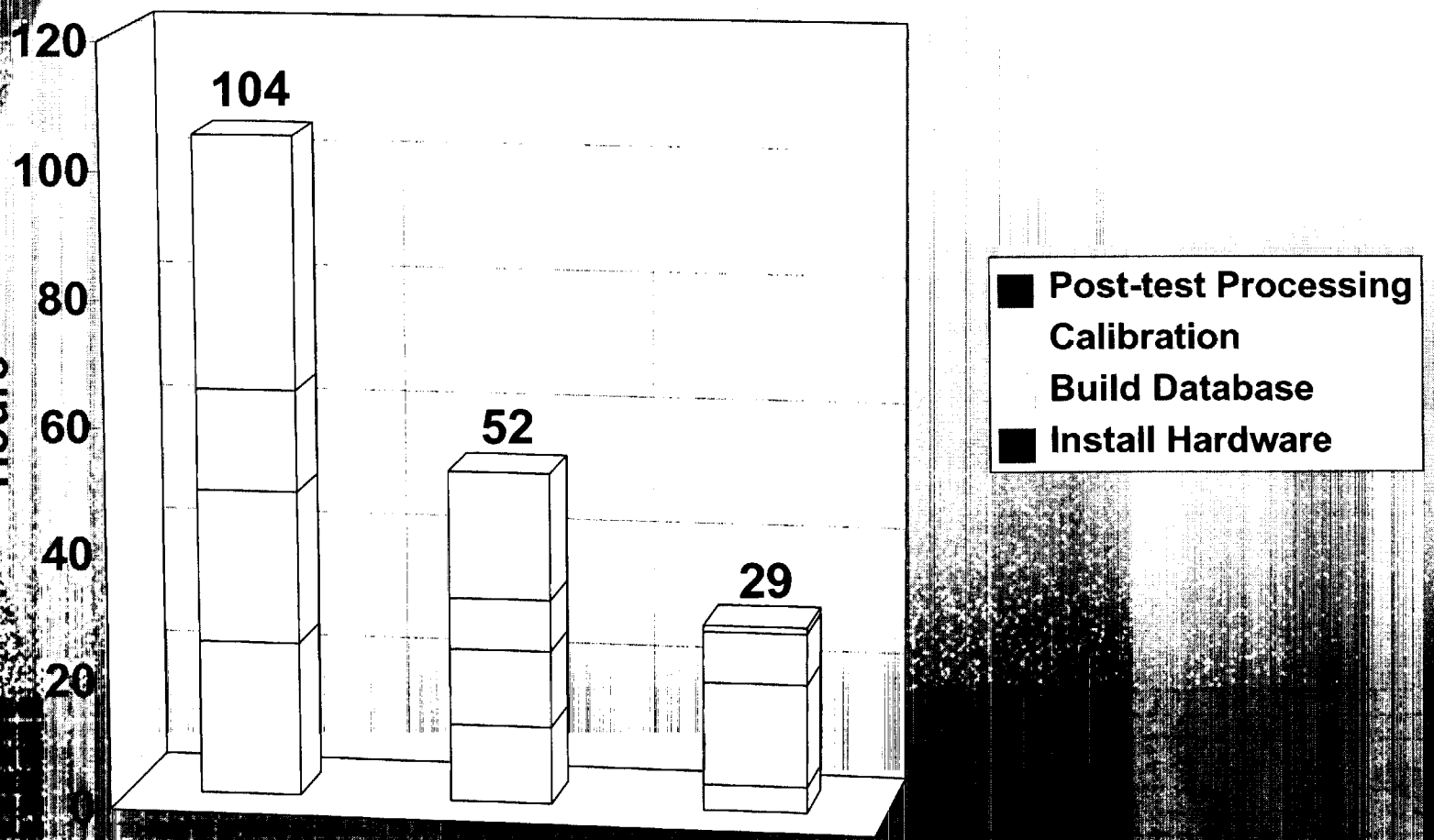
Evaluation Phase

Metric: Channel Count & Scan Rate



Evaluation Phase

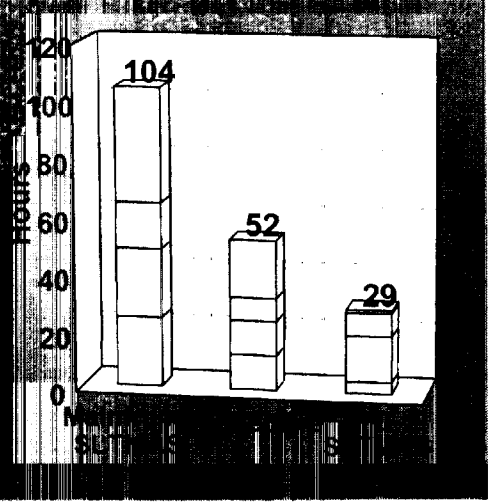
Metric: System Operations Time



Take text out of sample chart

Evaluation Phase

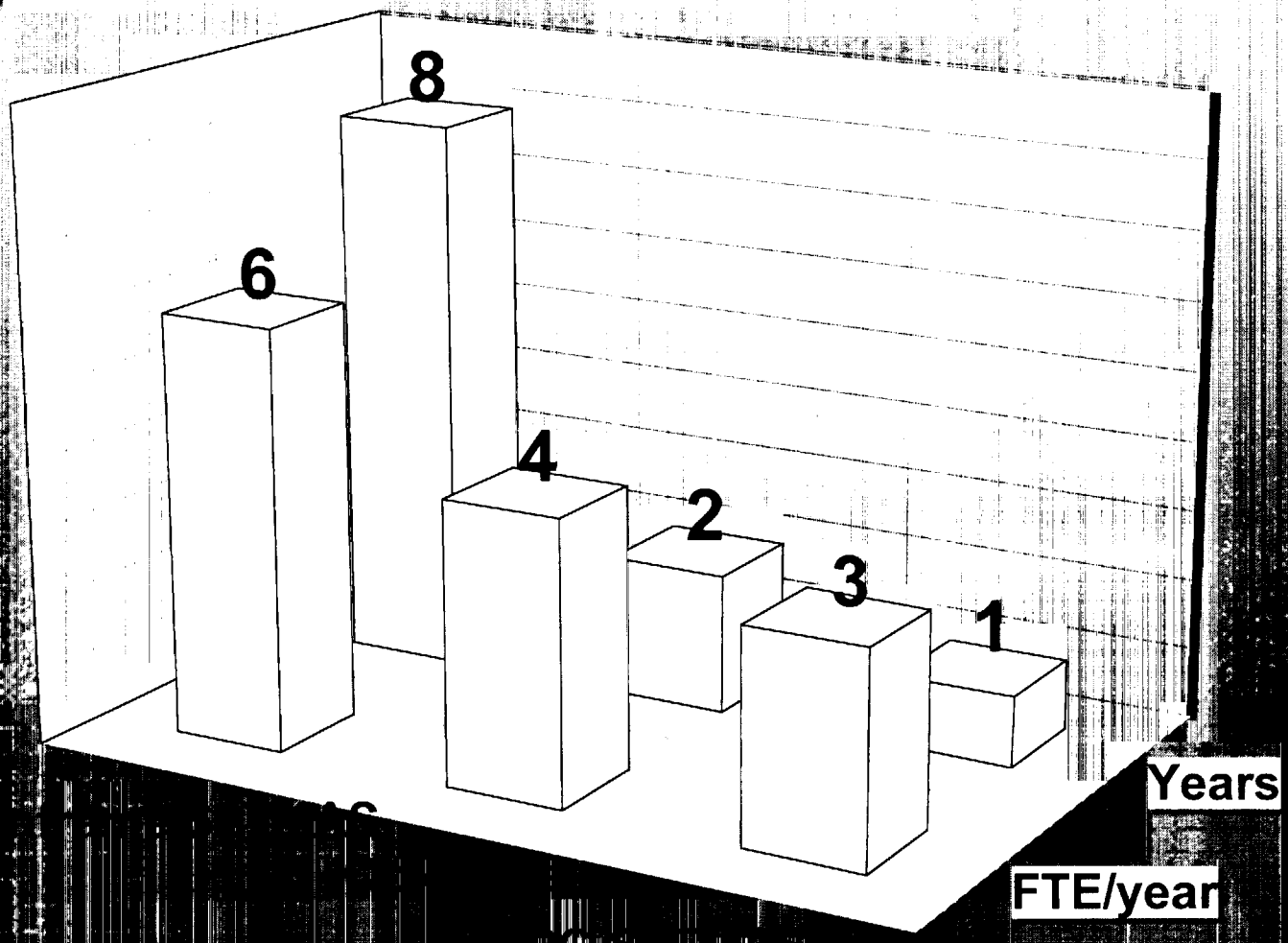
Metric: System Operations Time



Make back row red, front blue
animate year then FTEYEAR one at a time

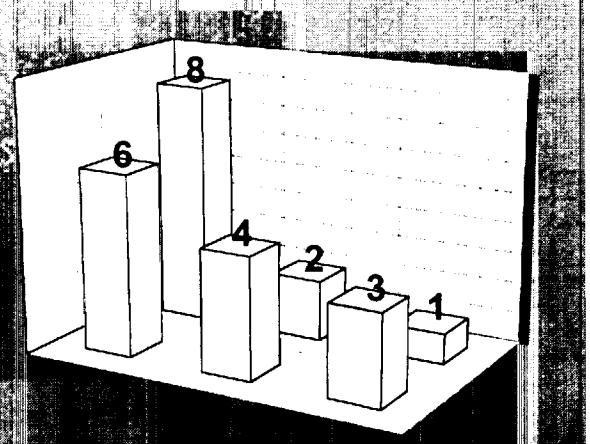
Evaluation Phase

Metric: SLTMAS Development FTEs & Years



Evaluation Phase

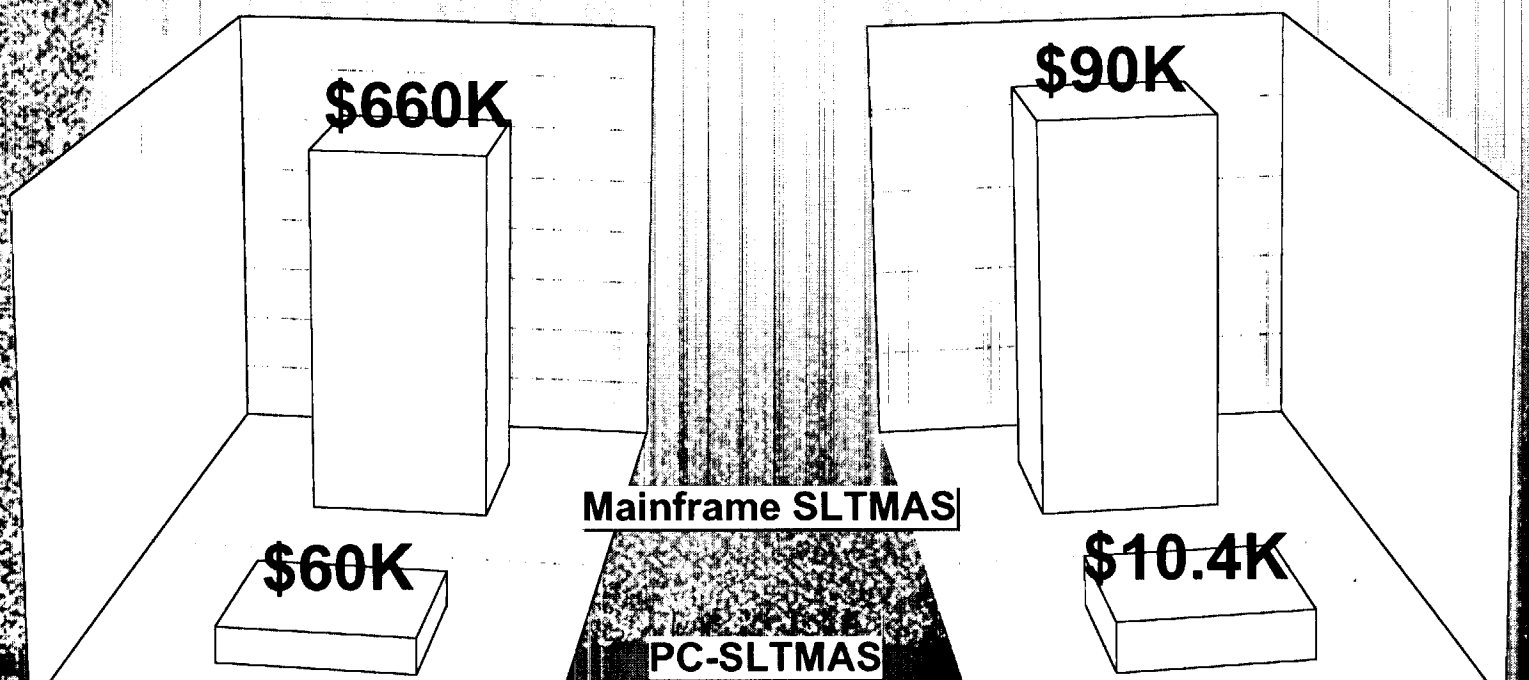
Metric: SLTMAS Development FTEs & Years



- Make red back, blue front
- animate mainframe 1st, leave the # of animations the same

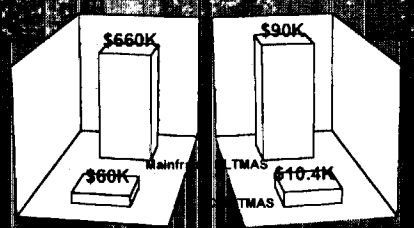
Evaluation Phase

Metric: System Upgrade & Maintenance Costs

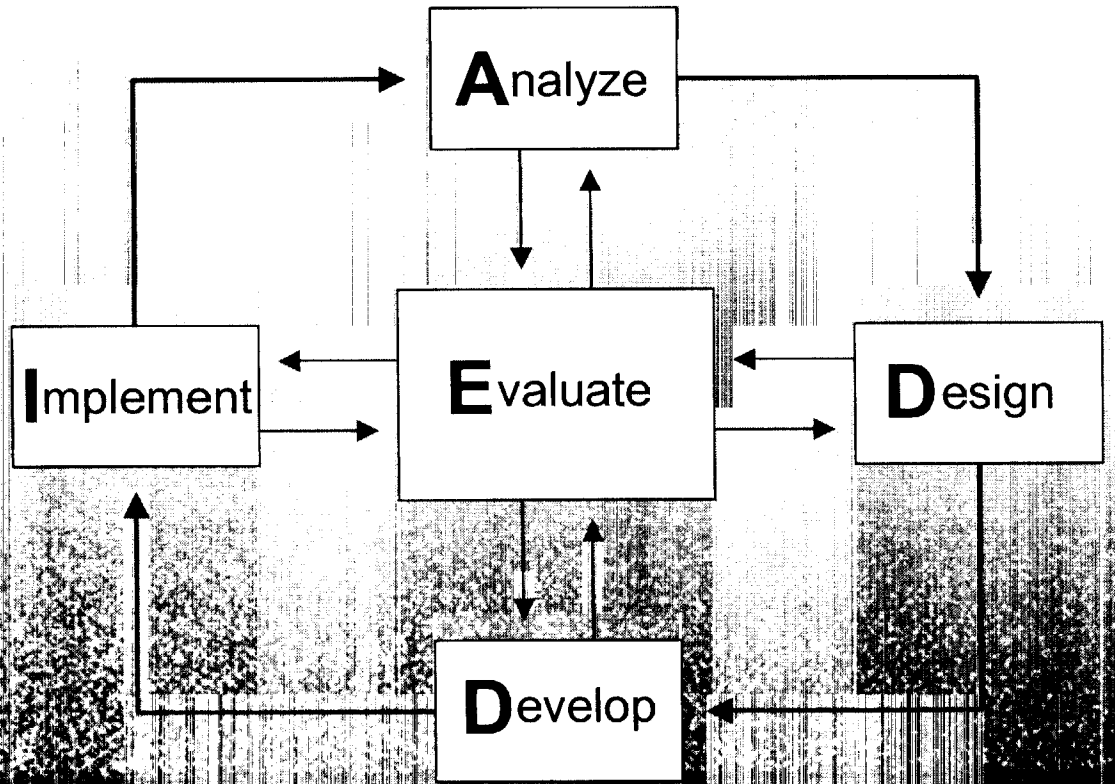


Evaluation Phase

Metric: System Upgrade & Maintenance Costs



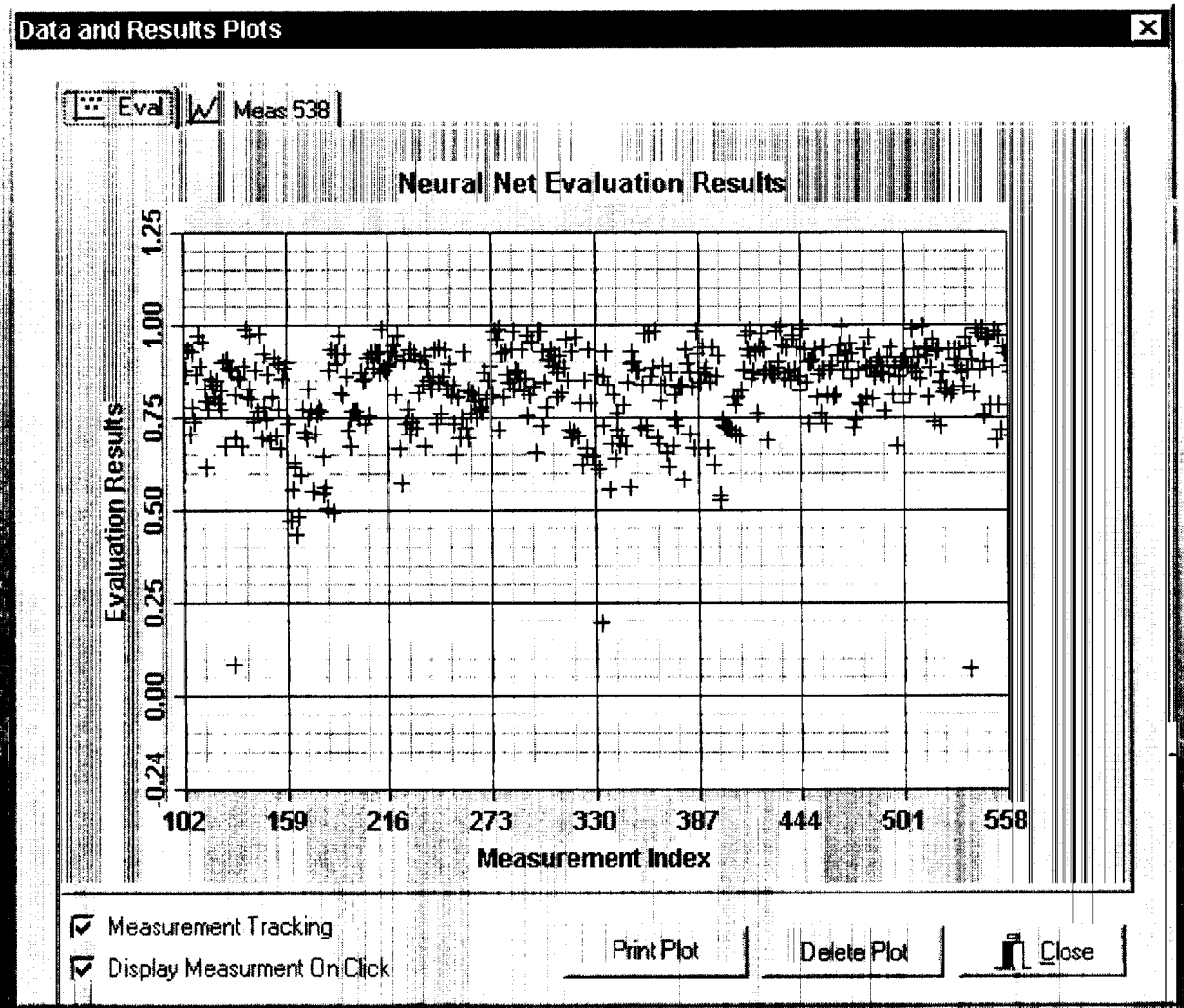
Continuous Improvement Model



Continuing PC-SLTMAS Improvements

- **Implementation phase of next Continuous Improvement cycle**
  - **Neural Network to evaluate measurement quality**
  - **Real-time finite element model (FEM) displays**
  - **Data synchronized to Global Positioning Satellite time**

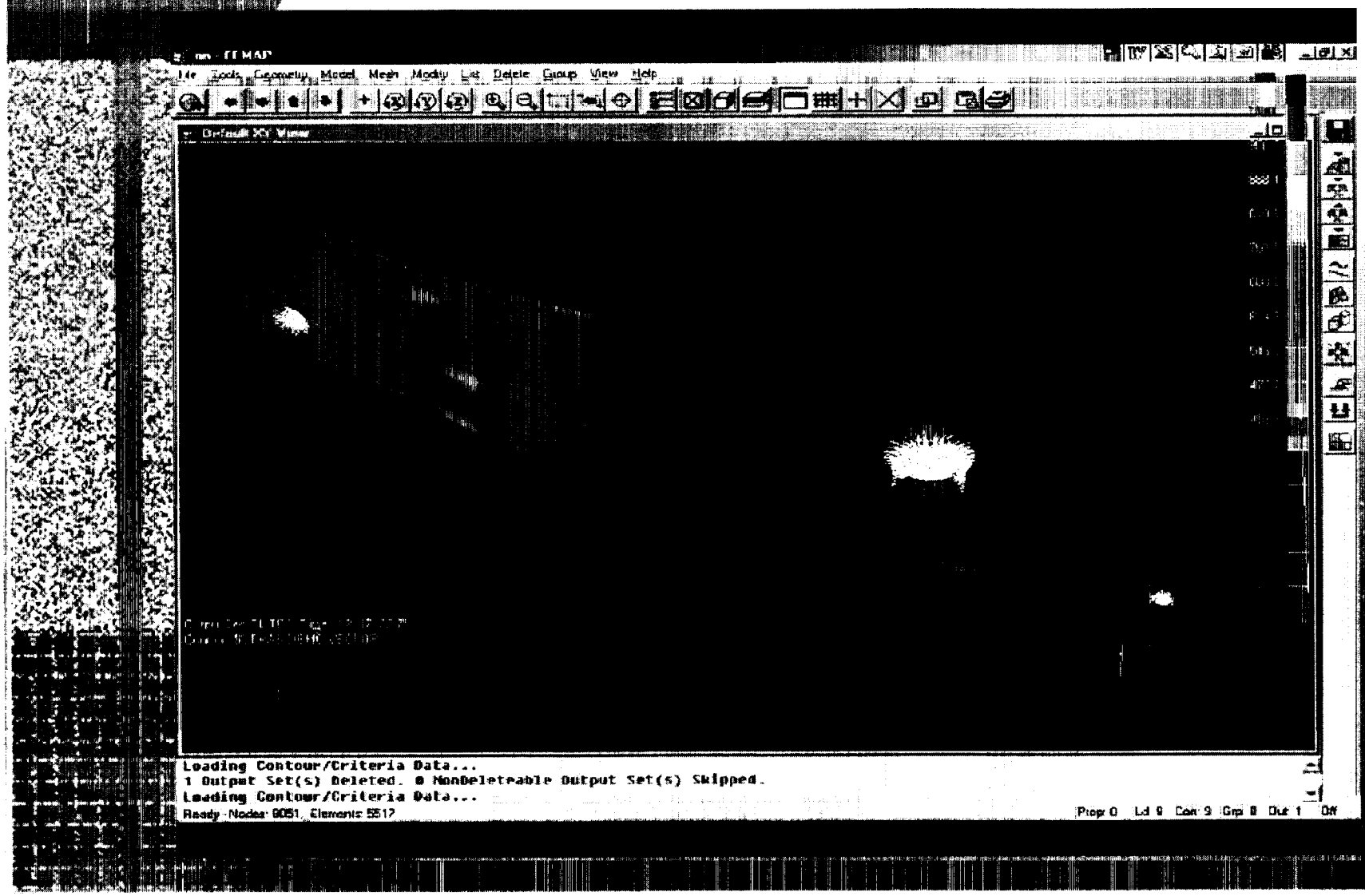
PC-SLTMAS Neural Network Measurement Evaluation



Rainbow needs to go inside black area
use still Bob sent

PC-SLTMAS

Real-time FEM Display



Add transparent ADDIE model

Conclusion

- **ADDIE Continuous Improvement process functioned extremely well**
  - **Team members "bought into" the process fully**
  - **Major issues were identified and handled effectively**
  - **Surpassed all performance objectives**
  - **PC-SLTMAS configuration includes capabilities previous technologies could not provide**